Way ahead for collection 3
OMI NO2 standard and NRT product

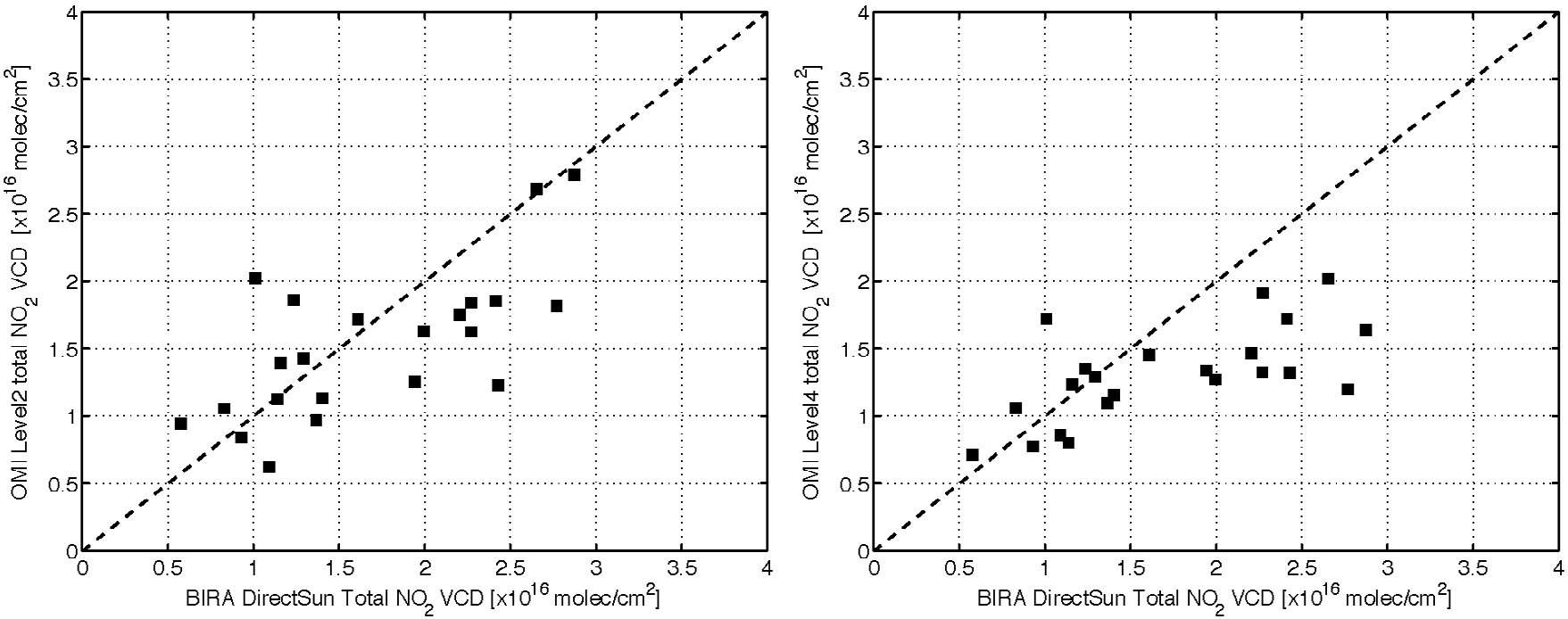
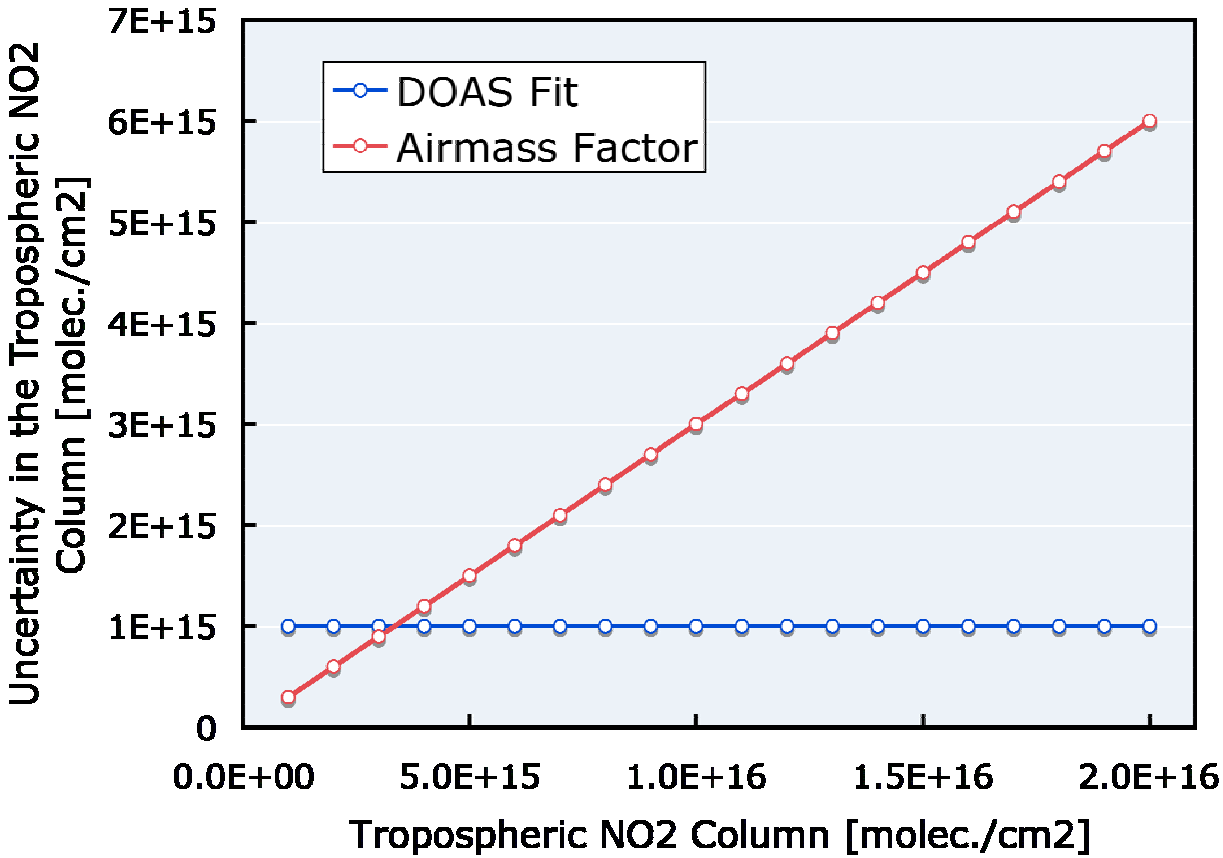


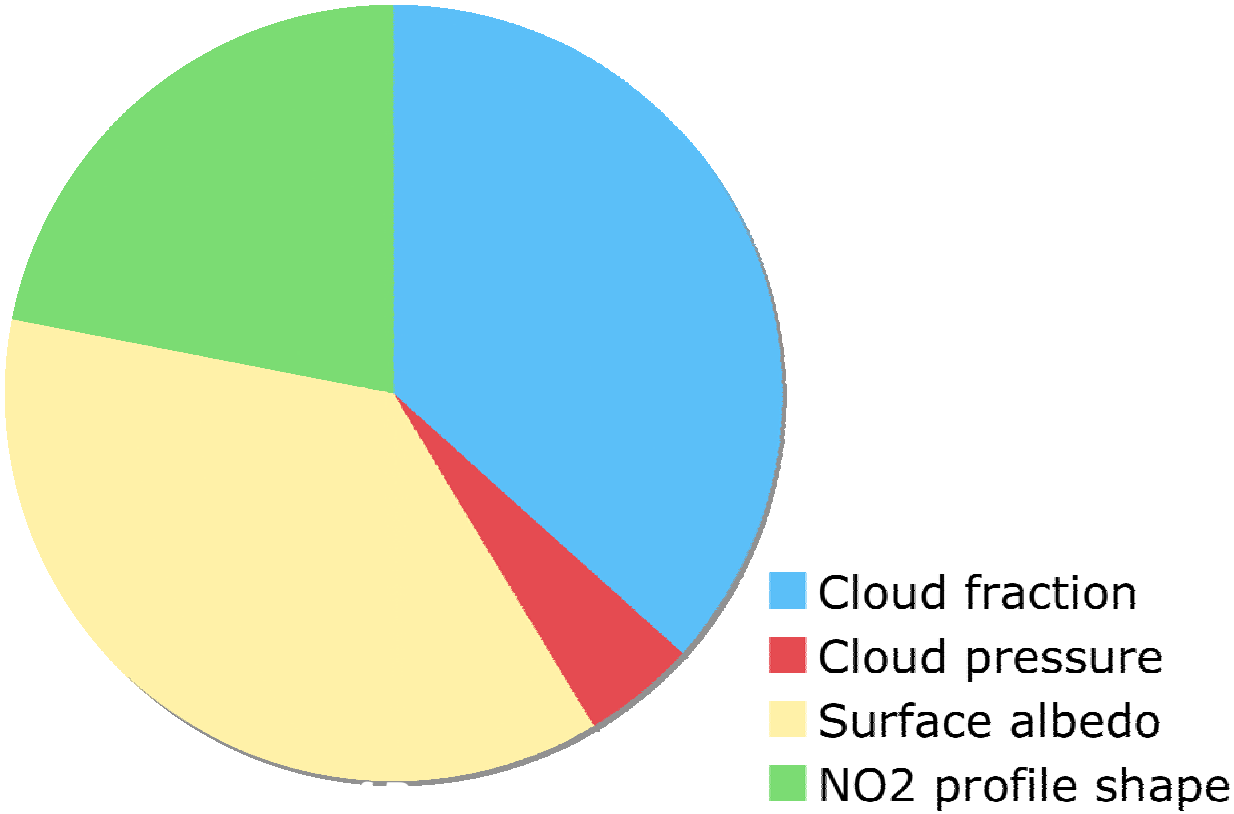
Figure 5. Top panel: All direct-sun tropospheric NO_2 observations, with OMI tropospheric NO_2 during clear days overplotted. Bottom panels: Correlations between NO_2 from OMI L2 (left panel) and OMI L4 (right panel) and the most closely collocated observation by the BIRA direct-sun instrument. See Table 6 for correlation statistics.

Tropospheric NO_2 Uncertainties



For moderate and heavy polluted conditions the uncertainty is dominated by the air mass factor contributions. (Veefkind et al, KNMI)

Airmass Factor Error Contributions for trop NO2 retrieval



Way ahead for OMI NO2 standard and NRT product

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Way ahead for the 2 NO2 products from OMI:

- Use same surface albedo data base for both products (OMI based)
  this will result in a reduction of 50 % in differences
- Use exactly same approach for cloud correction: some improvement
- Need more validation data to test several profile and stratospheric approaches

Realize

- SCIAMACHY NO2 products have same type of differences
- Error trop. NO2 column from current satellites will be between 30 – 50 % for polluted conditions
- Most ground based /surface meas. have errors between 30 – 50 %
- Except for direct sun observations, photolytic NO2 surface observation

Intercomparison and assimilation of NO2 satellite data with regional-scale air quality models for the Netherlands and Europe

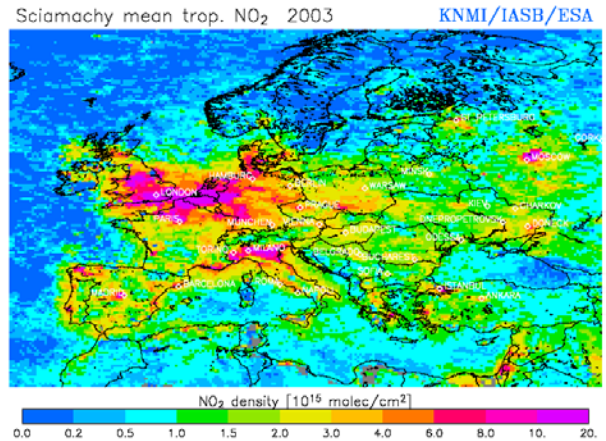
Henk Eskes, Ruud Dirksen, Pepijn Veefkind,
Ronald van der A, Suzanne Jongen, Pieternel Levelt
Royal Netherlands Meteorological Institute (KNMI), Netherlands

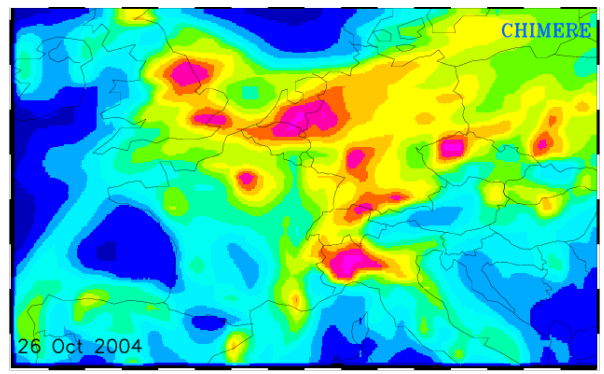
- Comparisons of satellite NO2 with air quality model CHIMERE
- Air quality forecasting/assimilation in GEMS / PROMOTE
- Air quality monitoring and forecasting in the Netherlands

Intercomparison of SCIAMACHY NO_2, the Chimère air-quality model and surface observations

N. Blond, F. Boersma, H. Eskes.
R. van der A, M. van Roozendael,
I. De Smedt, G. Bergametti,
R. Vautard

JGR 112, 2007, doi: 2006JD007277





Intercomparisons Chimère, SCIA and surface observations

KNMI

Motivation:

- Lack of profile observations of NO_2 for validation purposes: use model as intermediate for indirect validation study

Approach:

1. Compare Chimere with surface observations
2. Compare Chimere with SCIAMACHY

Results in indirect validation of SCIAMACHY with surface data

Approach step 2:

- Space-time collocation of Chimère fields to individual SCIA pixels
- Application of averaging kernels:
  Simulated SCIA-equiv column = kernel vector • model NO2 profile
- One year of SCIA data, 2003; Cloud free (cloud radiance < 50%)

Advantages:

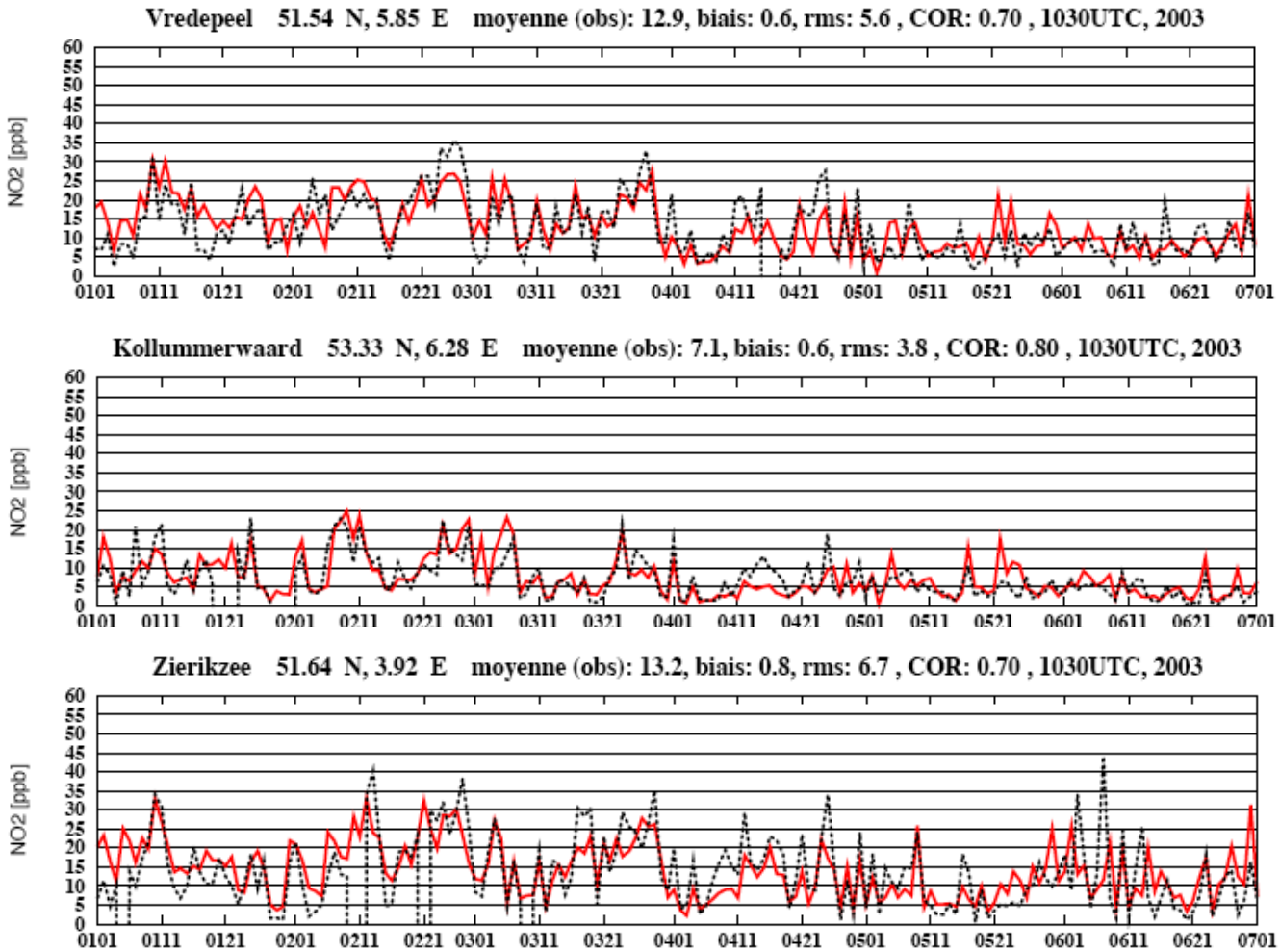
- Compare model-SCIA under exactly same conditions (e.g. cloud free)
- Comparison independent of profile shape assumptions in the retrieval

Chimère and surface observations (RIVM, NL)

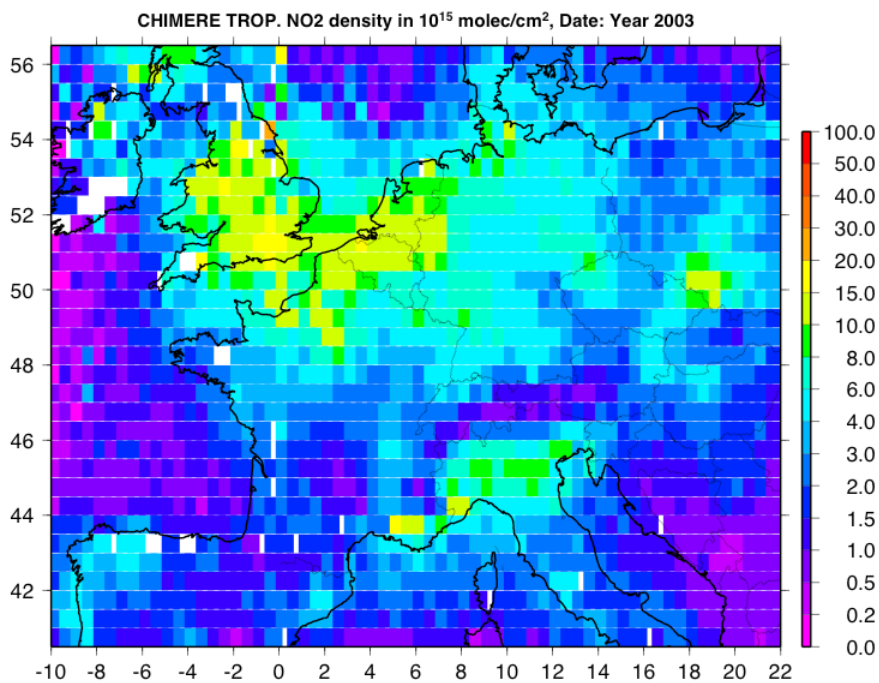
NO2

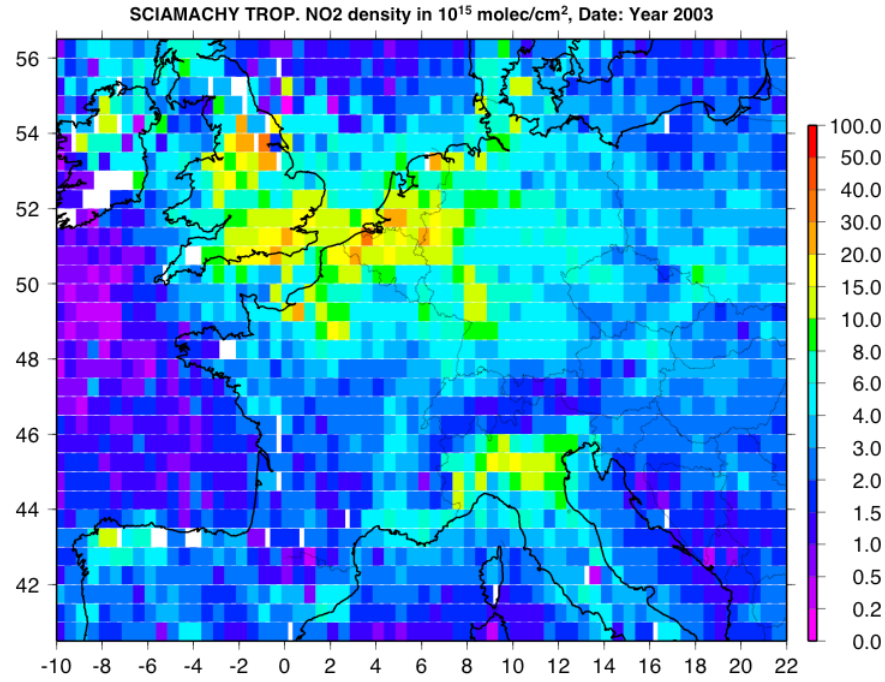
- surface observation
- Chimère

Netherlands:
(rural stations)
Bias 0.1 ppb
RMS 7.2 ppb
Correl. 0.66



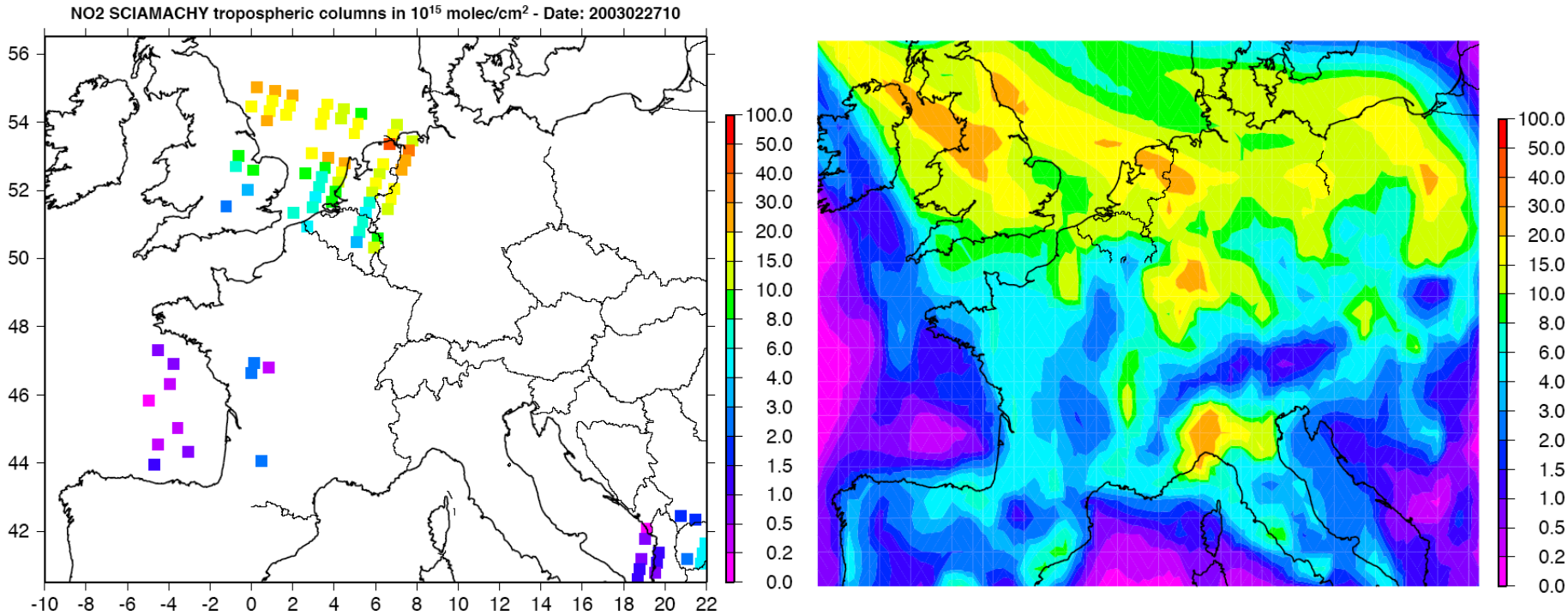
SCIAMACHY vs. Chimère: yearly mean





Yearly-mean bias = 0.2 10^{15} molec cm^{-2}, RMS 2.9 10^{15}, correl.coeff. 0.73
Cloud-free pixels

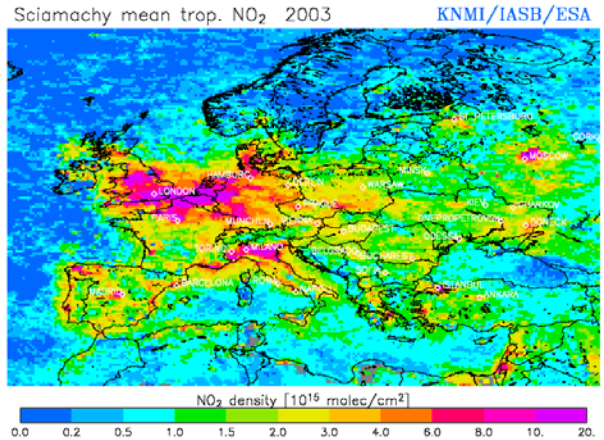
SCIAMACHY vs. Chimère: 27 Feb 2004

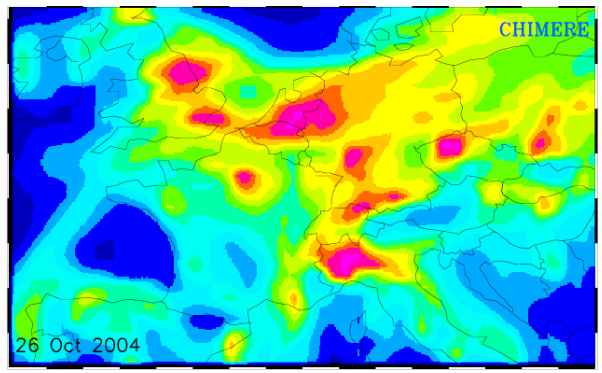


Conclusions NO_2 comparisons

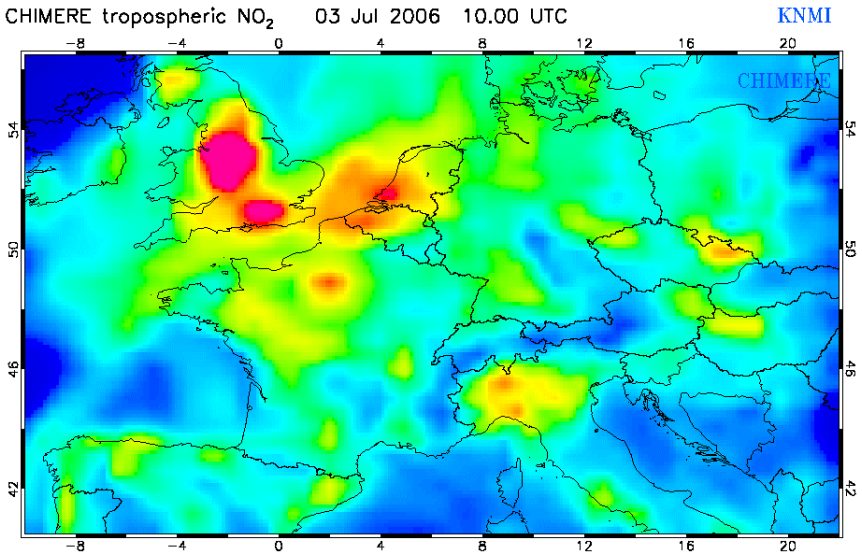
SCIAMACHY - Chimère - surface

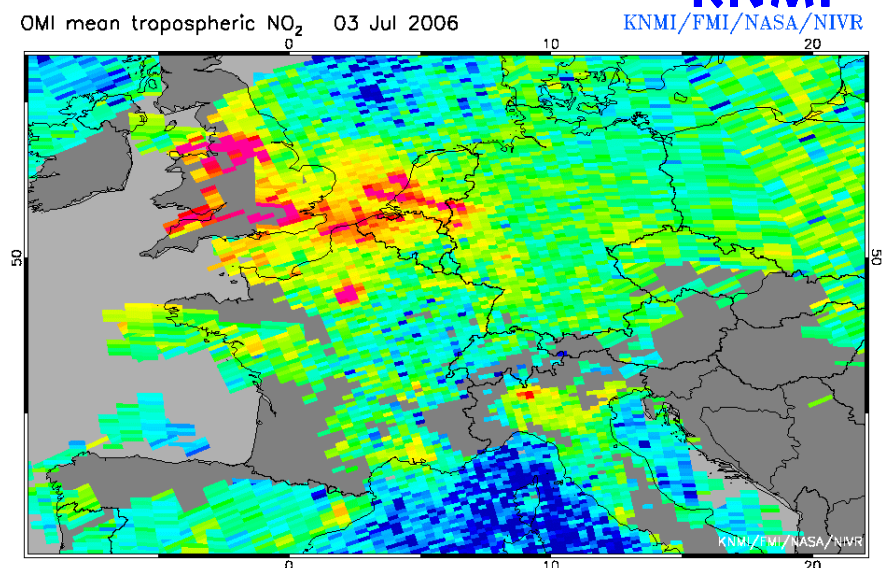
- Yearly mean:
  - small bias SCIA - Chimère and Chimère - surface
  - Correlation coefficients 0.7 typically
- SCIA and Chimère resolution comparable
- Extended NO_2 plumes compare well
- Details show differences:
  - Seasonality (winter Chimère higher)
  - Sciamachy mean trop. NO_2 2003
  - Individual days
  - Distribution
  - Amount of detail

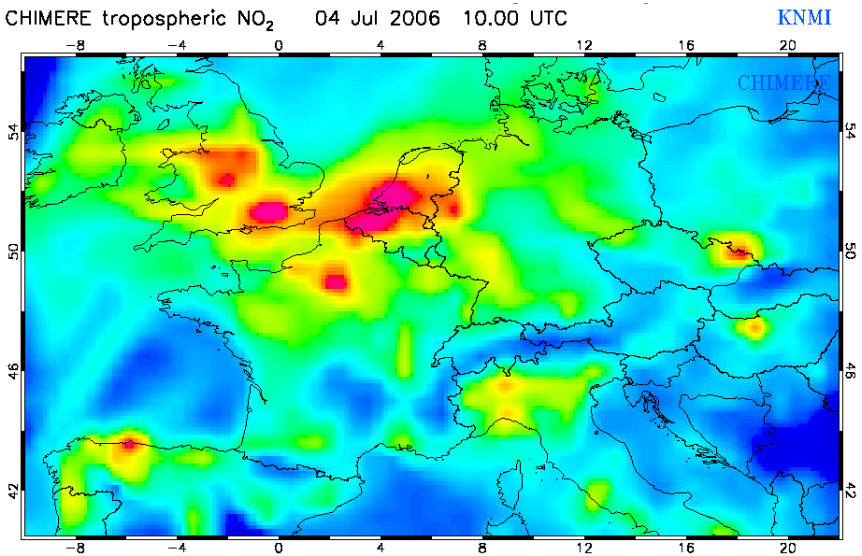


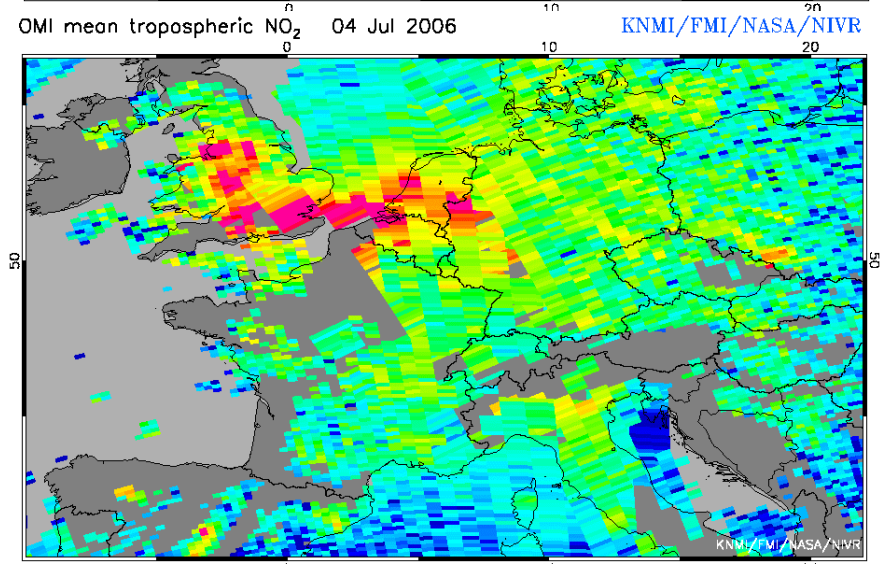


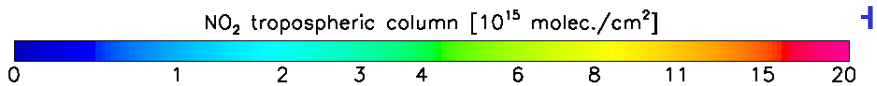
Chimère vs OMI

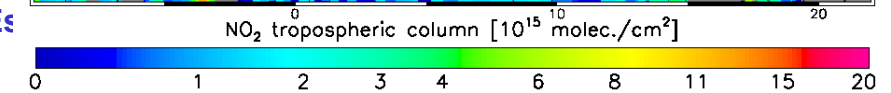












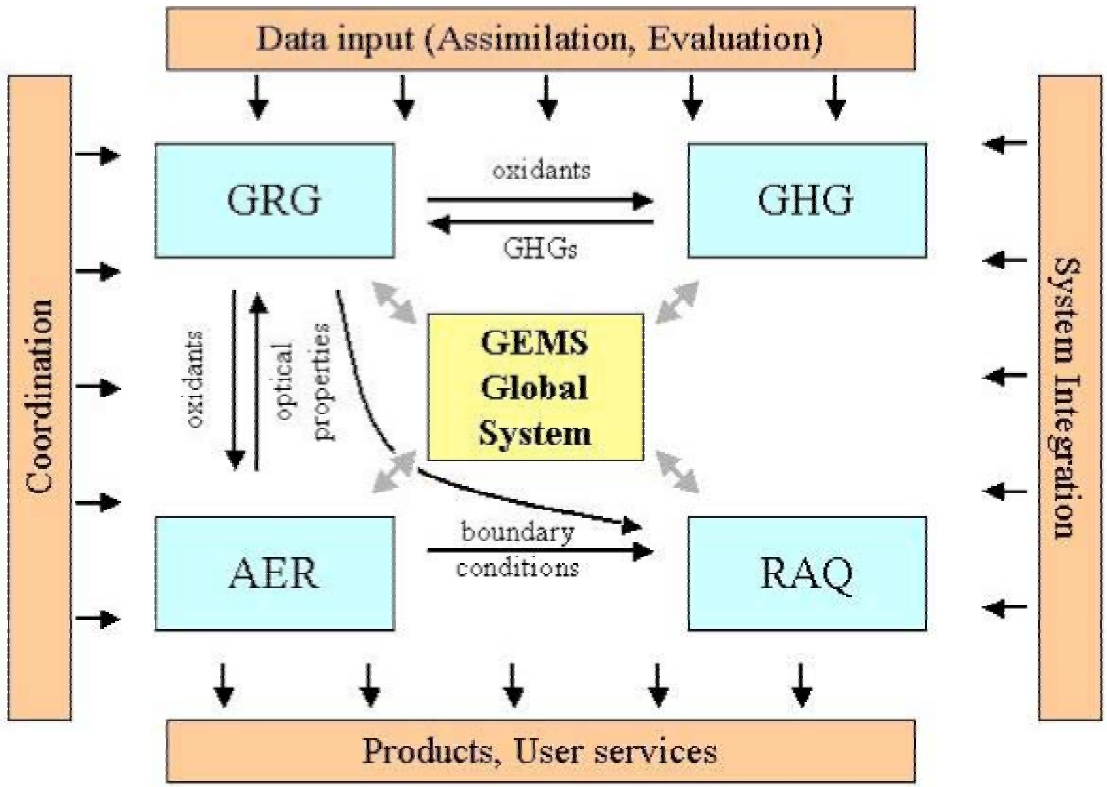
The GEMS Project

Global & regional Earth-system Monitoring using Satellite and in-situ data
EU 6FP, GMES, 2005-2009, 27 partners

Subprojects:

- Greenhouse gases
- Reactive gases
- Aerosols
- Regional air quality

First (trial) reanalysis
(period 2003/2004)
will start at end of 2006



H. Eskes, P. Levelt, AURA Science Team Meeting, Sep 2007

GEMS: Regional air quality subproject

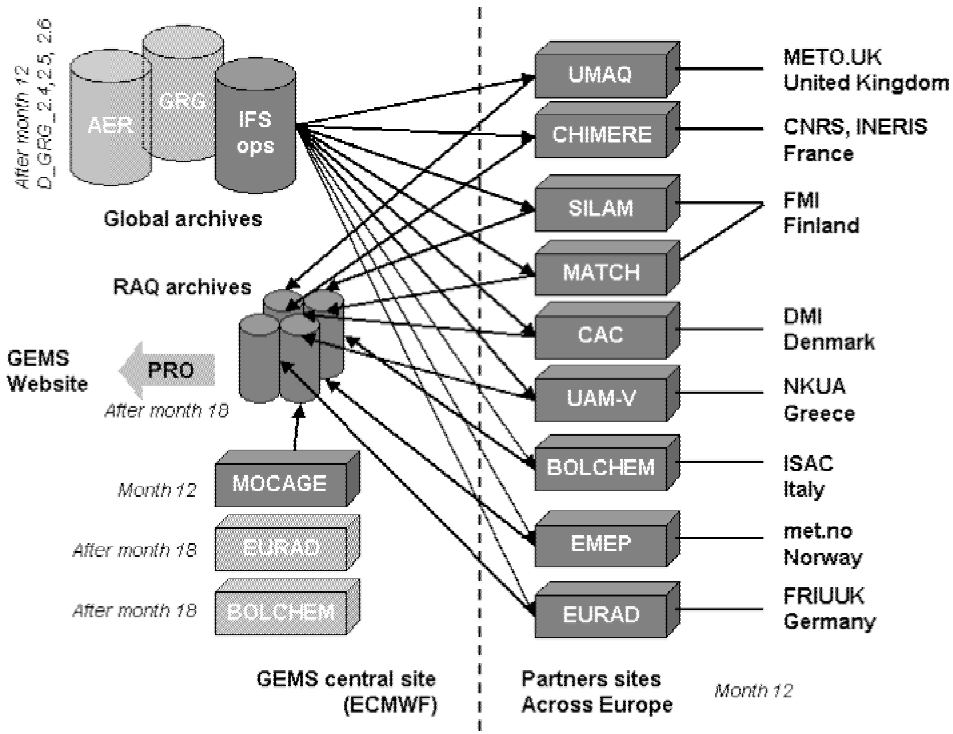
KNMI

Aspects:

- Many of the European regional AQ modelling groups involved
- Intercomparison of 11 European RAQ models on GEMS website
- Boundary conditions from GRG, AER
- Chemical assimilation at the regional scale (surface observations)
- NRT access to surface data
- Ensemble forecasts

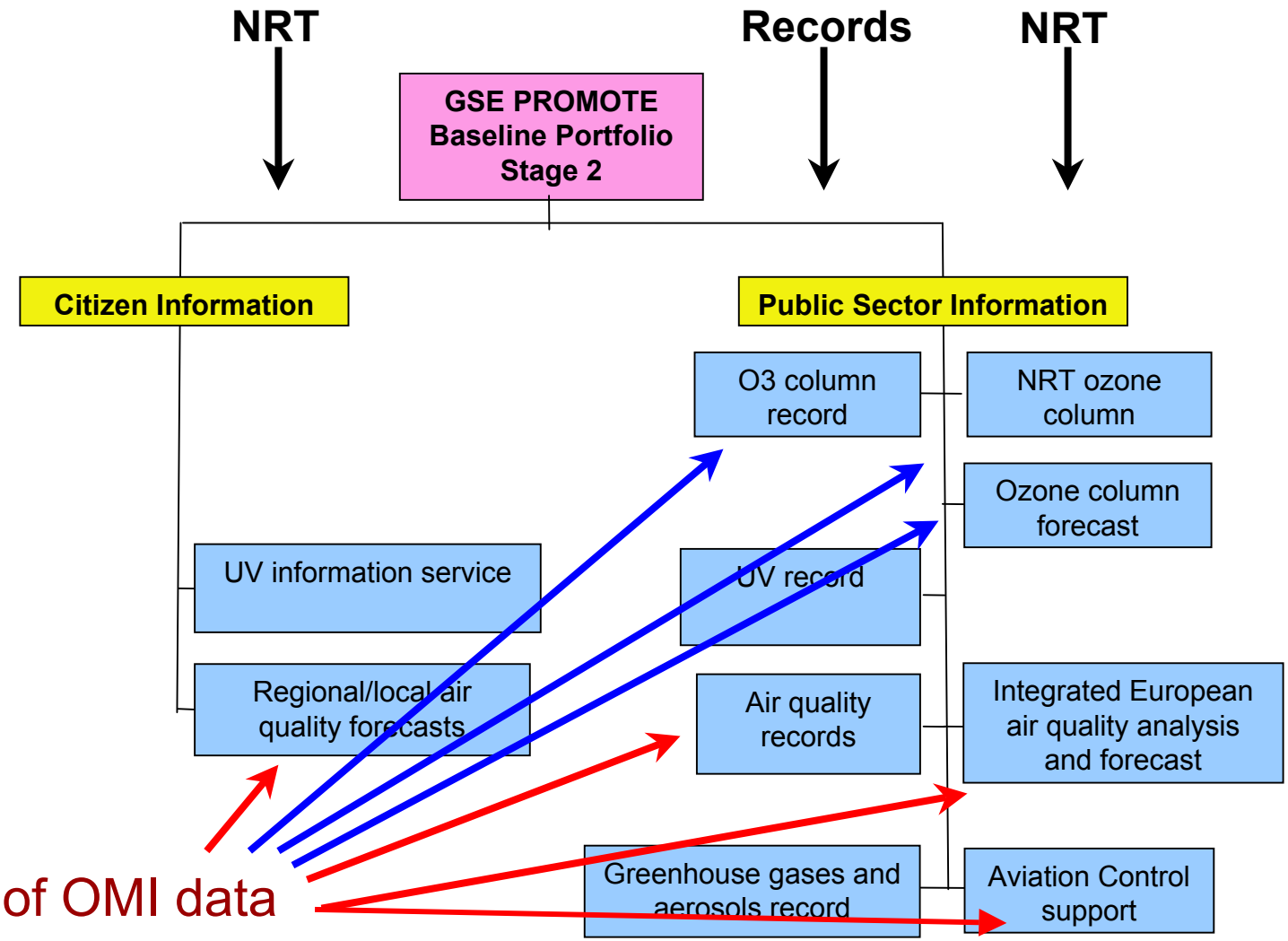
OMI and GEMS-RAQ:

- OMI nrt NO2 will be included in intercomparison
- OMI NO2 products available for assimilation in RAQ models



OMI and PROMOTE

http://www.gse-promote.org



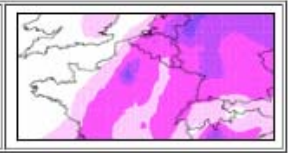
European ensemble air-quality forecast

KNMI

Aspects:

- PROMOTE and GEMS ensemble will merge into one European activity MACC lead by ECMWF
- Five key models:
  - Eurad (Cologne Germany, Hendrik Elbern),
  - Chimere (CNRS/INERIS France),
  - Mocage (Meteo France),
  - Lotos-Euros (TNO, Netherlands),
  - Silam (FMI Finland)
- Ensemble forecasts now available on PROMOTE web site, based on Eurad, Chimere and Mocage
- Near-real time OMI NO2 for routine verification/validation of GEMS ensemble

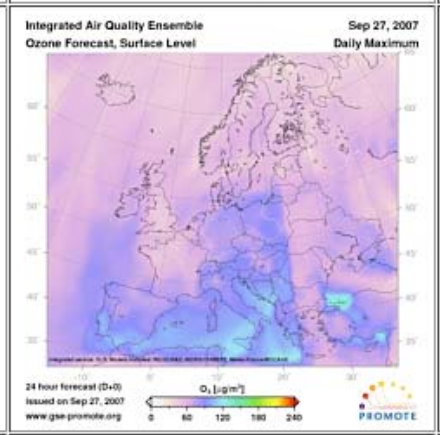
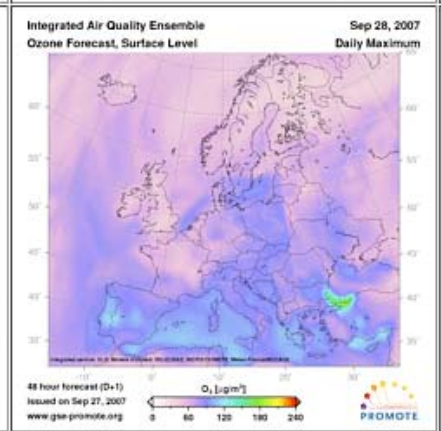
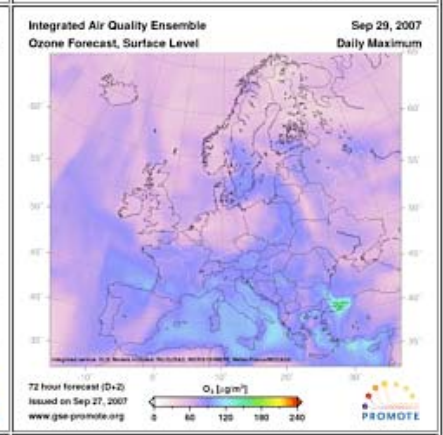
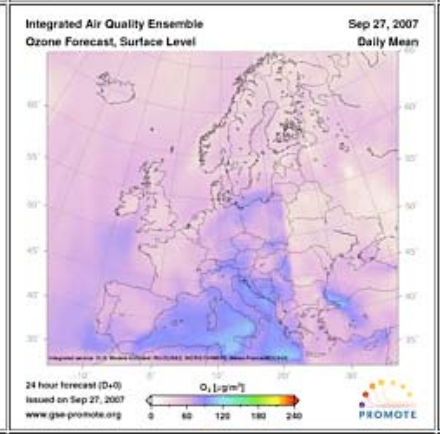
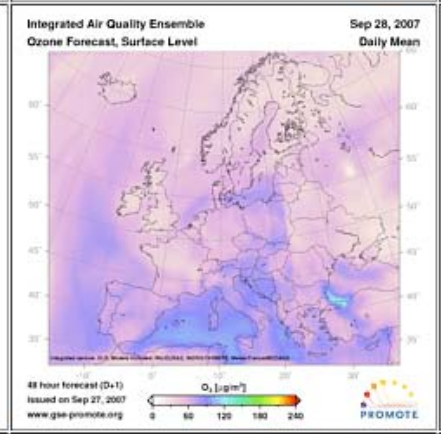
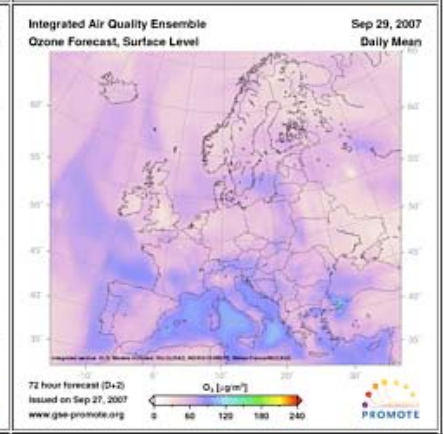
Integrated Air Quality platform



Integrated air quality platform

This service provides an ensemble forecast of air pollutant concentrations for all of Europe. Ground level concentrations of ozone, nitrogen dioxide and particulate matter derived from several well established and validated chemistry-transport models are integrated. The final product is based on an ensemble approach in order to get the best result from a combination of different models. Forecasts up to two days (72 hours) are provided at a resolution of ~50km*50km. In the near future analysed maps will be available, too. They will be issued from simulations including assimilated in-situ observations. All products are availbale daily using near-real-time observational data from satellite and ground.

Latest Forecasts (preliminary results)

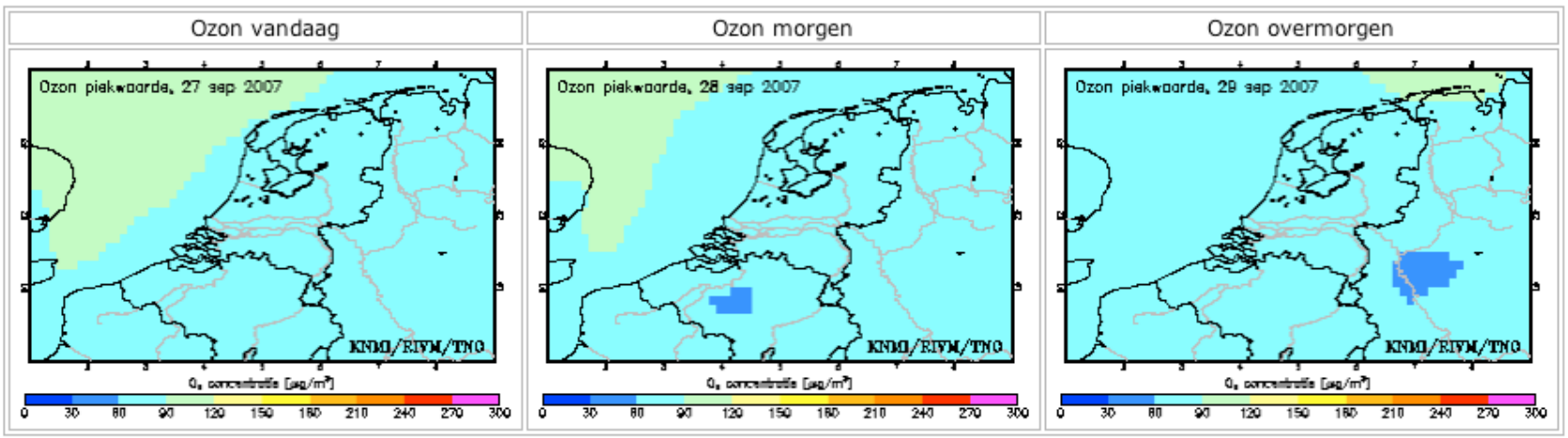
Pollutant	Latest Forecast Day+0	Latest Forecast Day+1	Latest Forecast Day+2
O_3 Daily Maximum			
O_3 Daily Mean			

Air quality forecasts for the Netherlands

Dutch SmogProg project, User Support Programme, NIVR
RIVM / KNMI / TNO, 2007-2008

- Based on Dutch LOTOS-EUROS model, and French CHIMERE model
- Two-day ozone forecast available on the web

http://www.lml.rivm.nl/



Air quality forecasts for the Netherlands

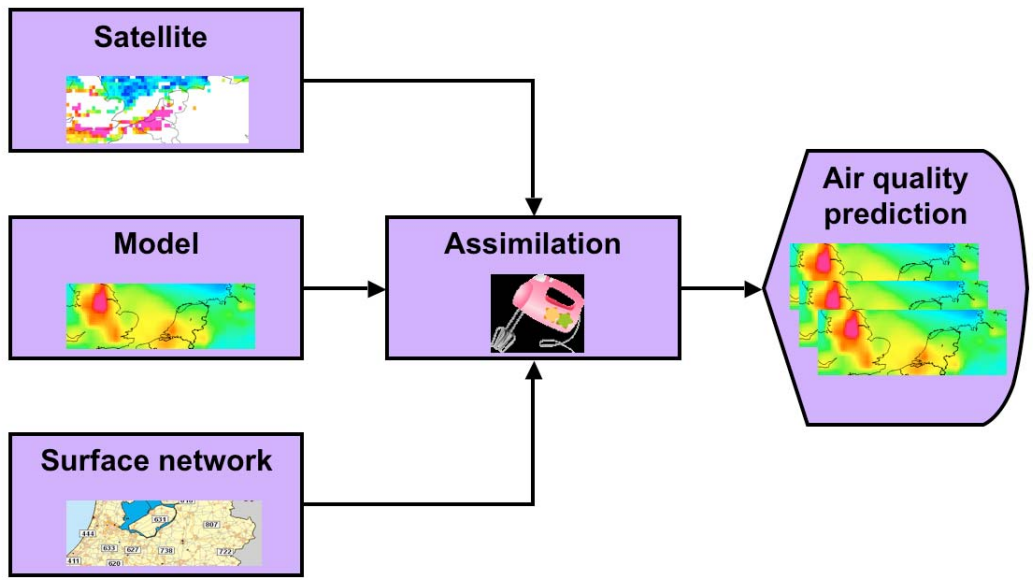
Dutch SmogProg project, User Support Programme, NIVR
2007-2008

Ensemble Kalman Filter
implemented in
LOTOS-EUROS
Surface data assimilation

Work ongoing to couple Lotos
Euros to OMI NO2 data (NRT)

First experiments with
OMI data in
LOTOS-EUROS
in October 2007

Couple Lotos Euros to Hirlam



H. Eskes, P. Levelt, AURA Science Team Meeting, Sep 2007

Summary and outlook

KNMI

Summary:

• Comparisons between satellite NO2 (OMI, SCIA), surface observations and the air quality model Chimère show high correlations and good general quantitative agreement - promise for future use of the satellite data

• Major activity in Europe to integrate NWP and atmospheric composition in the context of the GMES programme: GEMS and PROMOTE (MACC)

• European air quality forecast based on ensemble of models

• Dutch activity for AQ forecast Smog Prog

Outlook:

• Use of satellite data in assimilation to improve air quality forecasts

Backup

European ensemble air-quality forecast

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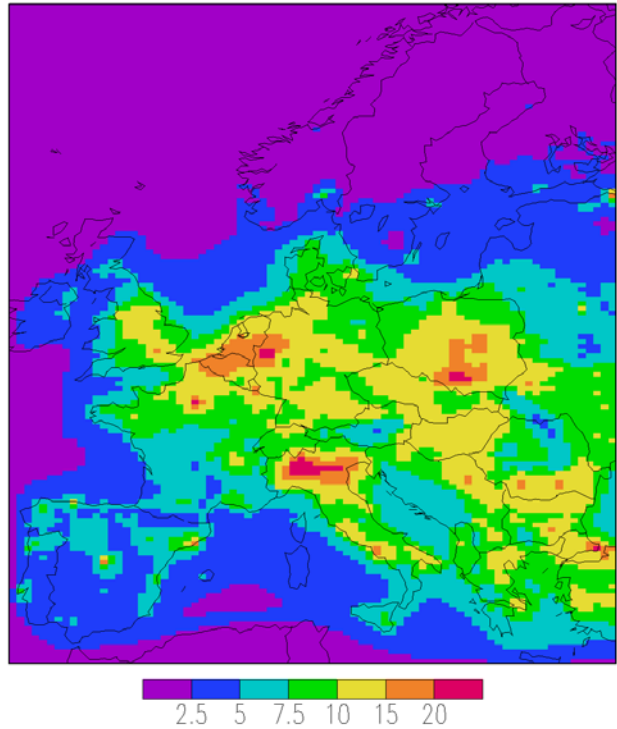
Data assimilation:

- Eurad (Cologne Germany, Hendrik Elbern):
  4D-Var / 3D-Var assimilation implemented,
  Surface data, MOZAIC ozone,
  NNORSY ozone profiles, MOPITT CO, SYNAER Aerosol
  First experiments with GOME, Sciamachy and OMI NO2 data
- Chimere (CNRS France),
  OI, working on Ensemble Kalman Filter implementation
  Assimilation of surface ozone and in future
  satellite data (e.g. Seviri-Sciamachy ozone, IASI)
- Mocage (Meteo France),
  OI, 3D-Var, 4D-Var
  Stratosphere: ozone, N2O
  Assimilation of surface observations, IASI

In future: Assimilation approaches will be rationalised for the European ensemble forecast (MACC proposal as follow-up of GEMS/PROMOTE)

Lotos-Euros model



Developed in the Netherlands
- LOTOS developed by TNO
- EUROS developed by RIVM

Model ingredients:
- Ozone and precursors, PM (aerosol), heavy metals, POP
- European domain with 0.5x0.25 degree (lon-lat)
- Dynamical boundary layer approach (4 layers, top at 3.5 km)
- ECMWF meteorological analyses (FU Berlin)
- Wet/dry deposition, emissions, transport, vertical exchange
- Gas-phase: CBM-IV or CB99
- Aerosol: fine/course, SO4, NO3, NH4, EC, OC, salt,

GEMS: Reactive gas subproject

KNMI

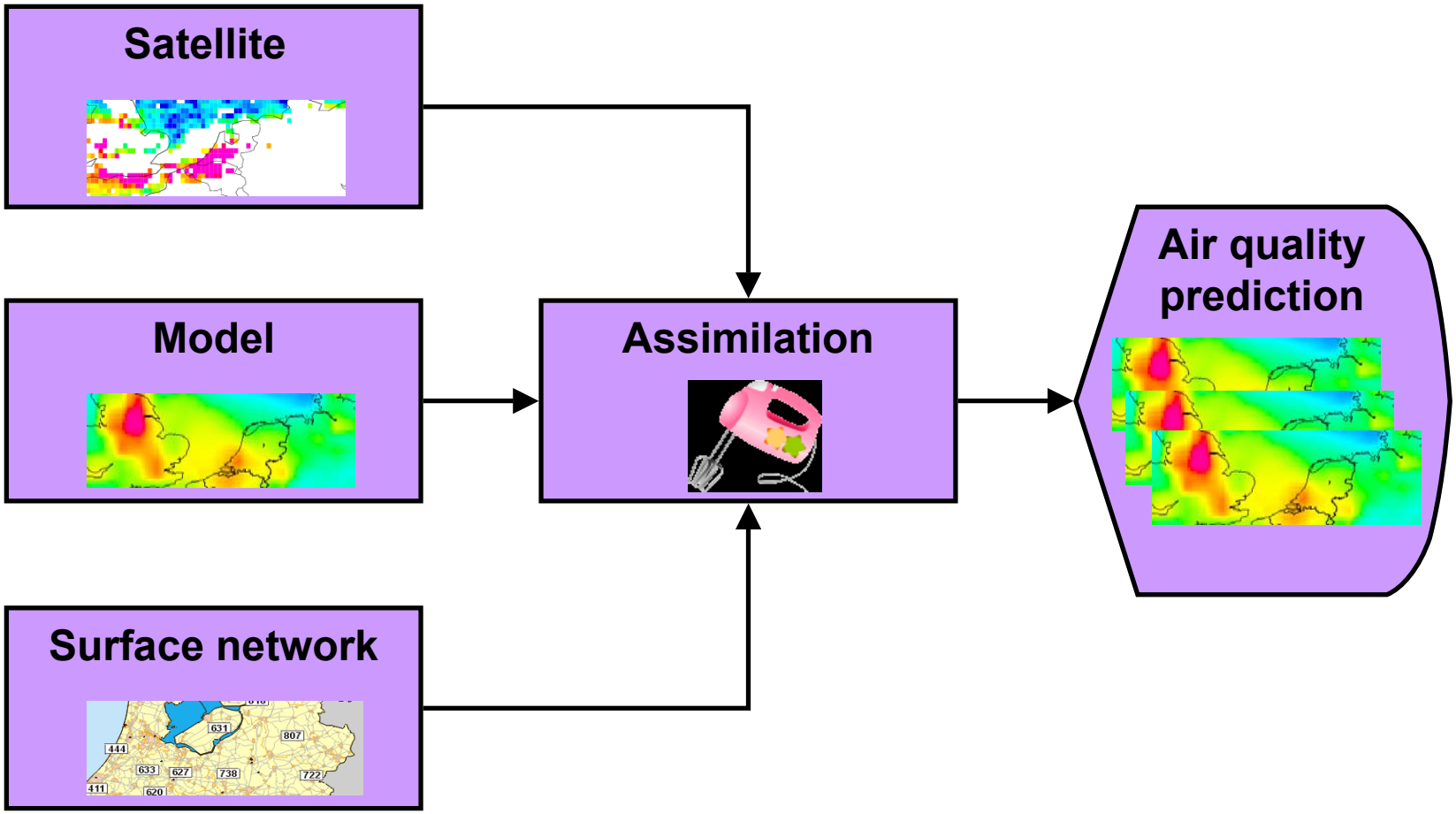
Aspects:

- Two way coupling of ECMWF model with three CTMs: Mozart, Mocage, TM5, coupling via OASIS-4
- Assimilation for ozone, CO, NO_2, SO_2, CH_2O, methane based on 4D-Var system of ECMWF
- Delivery of boundary conditions for RAQ
- Initial focus on troposphere

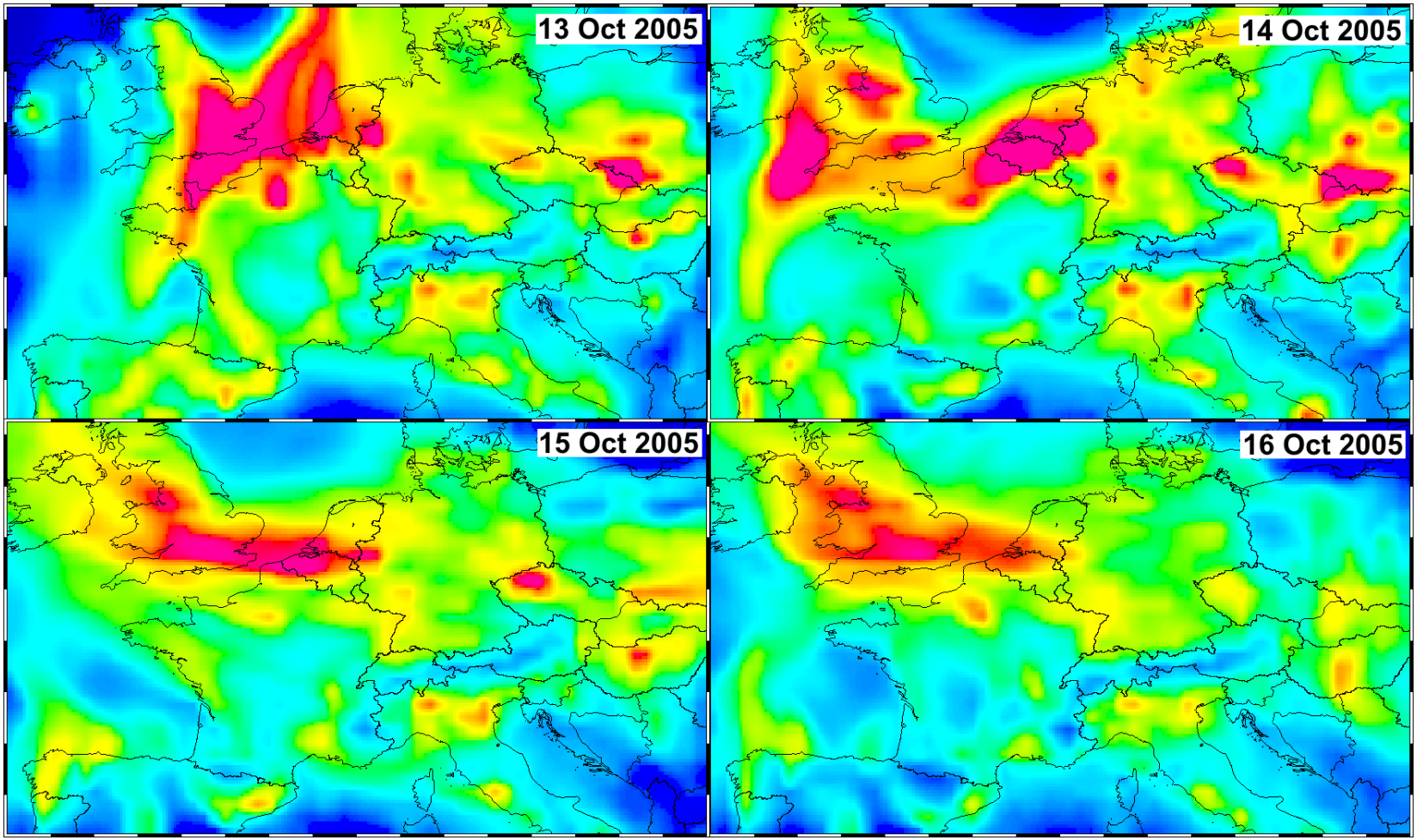
OMI and GEMS-GRG:

- OMI NO2, CH2O, SO2 will be considered for / included in the second GEMS reanalysis run
- Improve emissions (trends)

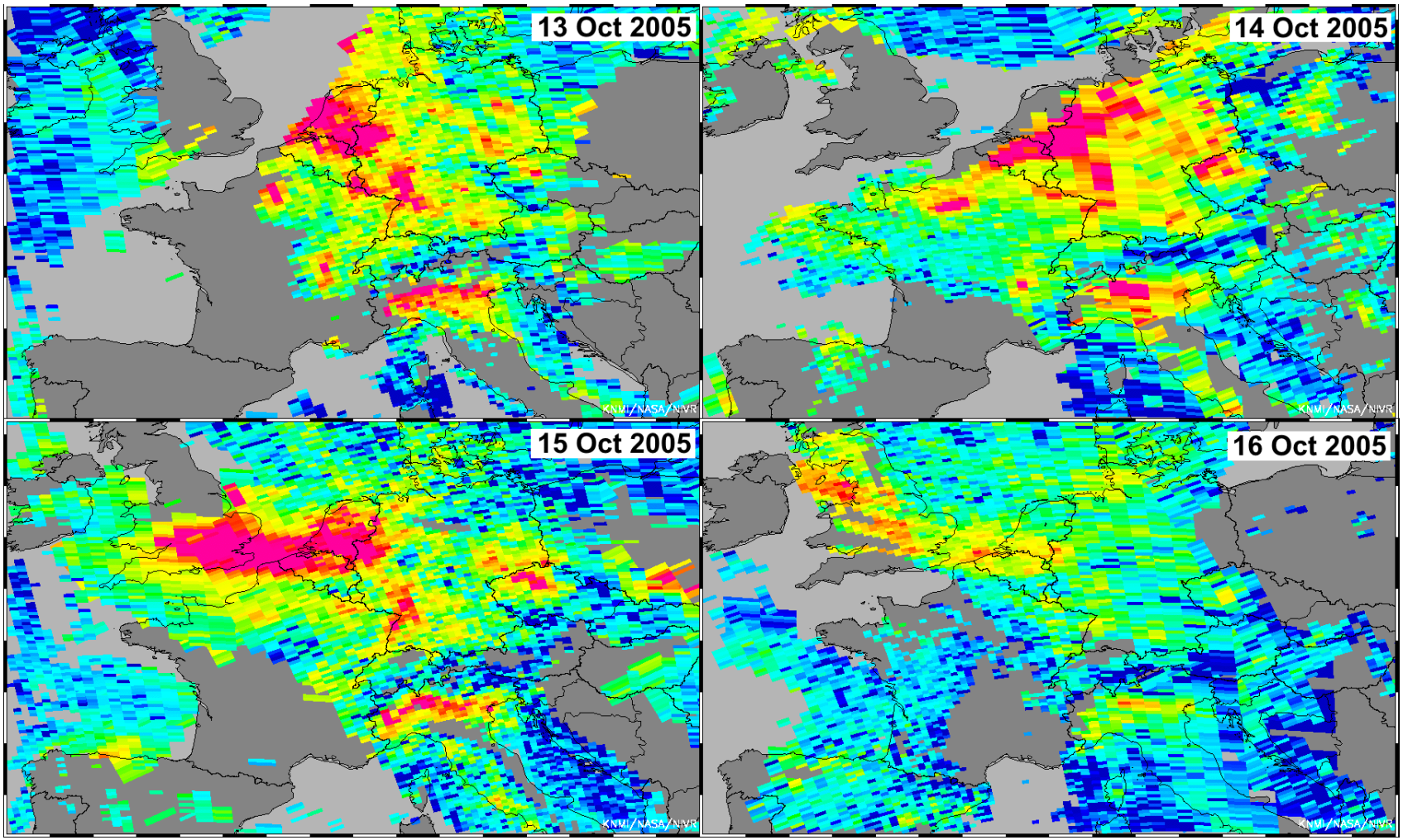
The aim


Satellite
Model
Surface network
Assimilation
Air quality prediction

Chimere @ OMI overpass time, 13-16 Oct 2005

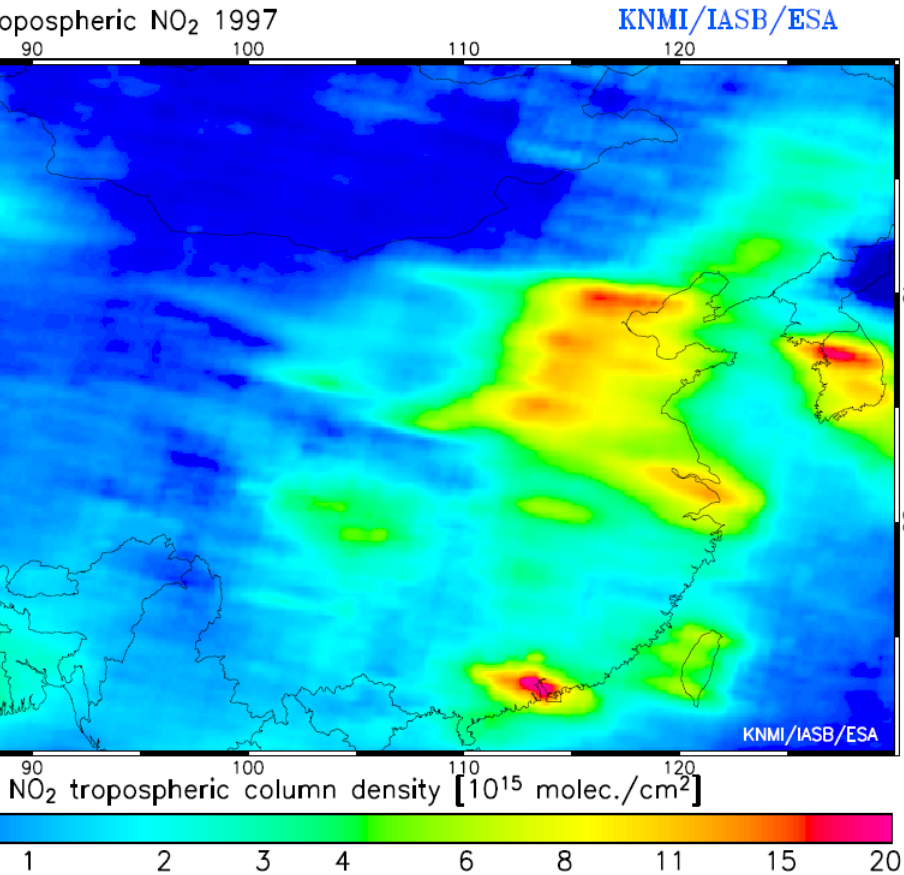


OMI near-real time NO2, 13-16 October 2005

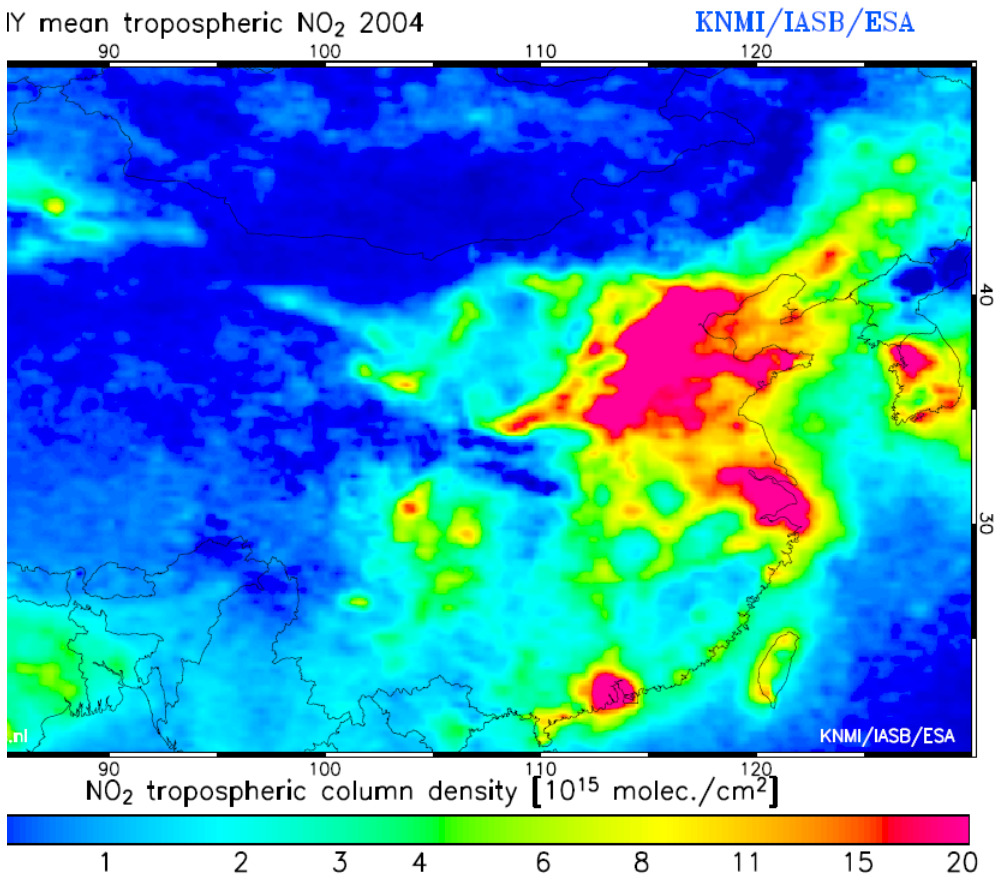


Trend over China

GOME, 1997

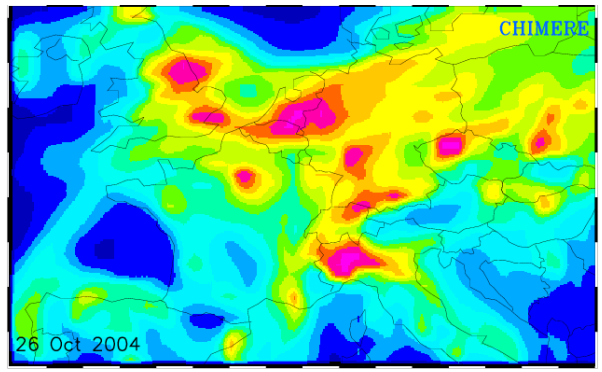


SCIA, 2004



H. Eskes, P. Levelt, AURA Science Team Meeting, Sep 2007

Chimère model



Developed in France
R. Vautard, H. Schmidt, L. Menut, M. Beekman, N. Blond, ...)
Operational air-quality forecasts: http://www.prevair.org/

Model ingredients:

- MELCHIOR chemistry (82 species, 333 reactions)
- EMEP emissions
- ECMWF meteorological analyses
- 15 vertical layers, surface - 200 hPa
- Boundary conditions from MOZART monthly-mean climatology
- 0,5 x 0,5 degrees